2000 Beneficial Use Reconnaissance Project

Work Plan for Lakes and Reservoirs

Idaho Department of Environmental Quality

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TABLE OF CONTENTS

LIST OF TABLES

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SUMMARY

The Beneficial Use Reconnaissance Project protocols use the best science and understanding available to characterize water quality based on biological community attributes and their environment. They provide statewide consistency in monitoring and data collection.

This protocol is applicable to lentic waters, that is, lakes and reservoirs. It describes the methodology and provides a list of required equipment and the forms for recording data. It does not describe data analysis nor interpretation.

INTRODUCTION

Creation of the Beneficial Use Reconnaissance Project

In 1993, the Idaho Division of Environmental Quality, hereafter referred to as the Department of Environmental Quality (DEQ), embarked on a pilot project aimed at integrating biological and chemical monitoring with physical habitat assessment as a way of characterizing stream integrity and the quality of the water (McIntyre 1993a). This project was also developed in order to meet the Clean Water Act requirements of monitoring and assessing biology as well as developing biocriteria (Water Environment Federation 1997). This pilot, named the Beneficial Use Reconnaissance Project (BURP), relied heavily on protocols for monitoring physical habitat and benthic macroinvertebrates developed by the DEQ in the early 1990s (Burton and Harvey *Draft*, Burton et al. *Draft*, Cowley 1992, Clark and Maret *Draft*). It closely followed the U.S. Environmental Protection Agency's *Rapid Bioassessment Protocols for Use In Streams and Rivers* (Plafkin et al. 1989). The BURP protocols were an attempt to use the best science and understanding available to characterize water quality based on biological community attributes and their environment. Because of the success of the 1993 pilot, the DEQ expanded the project statewide in 1994 (McIntyre 1994, Steed and Clark 1995).

The 1997 BURP work plan incorporated protocols for two new water body types; one for lakes and reservoirs and another for large rivers (Beneficial Use Reconnaissance Project Technical Advisory Committee 1997). The lake and reservoir reconnaissance-level protocol was primarily fashioned after Milligan et al. (1983), Mossier (1993), and U.S. Environmental Protection Agency (1997). This protocol was revised in 1998 (Beneficial Use Reconnaissance Project Lake and Reservoir Committee 1998) and again in this document.

Purpose

Protocols provide statewide consistency in monitoring and data collection as described in the *Coordinated Nonpoint Source Water Quality Monitoring Program for Idaho* (Clark 1990). This document describes the methodology and provides a list of required equipment and the forms for recording data.

This document does not describe data analysis nor interpretation. Interpretation of BURP data and any other relevant water-quality information is described in the DEQ's draft *Idaho Lake and Reservoir Ecological Assessment Framework* (Hoelscher et al. *Draft*). The framework outlines the process the DEQ proposes in determining whether aquatic life and salmonid spawning beneficial uses are being supported.

Goals and Objectives

The goal of the lake and reservoir beneficial use reconnaissance-level monitoring project is to develop protocol applicable to lentic waters focusing on cost-effective measures that relate to beneficial uses and respond to levels of human influence. *Post-Field Evaluation of the Beneficial Use Reconnaissance Project for Lakes and Reservoirs* has found this protocol with revisions applicable and feasible in a state with water resources as diverse as Idaho (Hoelscher *Draft*). They provide for the documentation of existing beneficial uses to the extent possible at a reconnaissance-level intensity.

The objective for the 2000 field season is to monitor lakes and reservoirs representing a range of human influences (*e.g.* minimally affected, degraded). These data will be used to supplement and validate the ecological assessment framework for lakes and reservoirs.

PRE-MONITORING STEPS

Criteria for Use

Lakes are easily identifiable, however, reservoirs may be confused with large rivers. Certain criteria distinguish lakes from small ponds and wetlands and reservoirs from riverine pools. Open water (*i.e.* not covered by emergent aquatic macrophytes) with a surface area greater than one hectare and less than about 8,100 h (20,000 ac) will characterize lakes. Thornton (1990) reported hydraulic residence time in reservoirs is greater than 14 d. (This criterion should be estimated if hydraulic residence time is unknown.) Waters that meet these criteria, open water with a surface area greater than one hectare but less than 8,100 h and hydraulic residence time greater than 14 d, will then be candidates for monitoring using the lake and reservoir BURP protocol.

Water Body Selection

Idaho has more than 1,300 named lakes and reservoirs (Milligan et al. 1983). About 40 are on Idaho's 1996 Clean Water Act § 303(d) list (Idaho Department of Health and Welfare 1997a). The following selection criteria are recommended in order to address current agency goals:

- lakes and reservoirs with minimal human influences (*i.e.* reference conditions);
- lakes and reservoirs with multiple levels of human influences;
- lakes and reservoirs previously sampled; and
- water-quality limited lakes and reservoirs [per Idaho's 1996 Clean Water Act § 303(d) list].

Lakes and reservoirs scheduled for sampling are listed in Appendix I. Inclusion of previously sampled waters aids in the evaluation of temporal variability. Lake Lowell, Mormon Reservoir, and Henrys Lake were sampled in 1997 and 1998 and will be sampled again.

Existing Data Review

Idaho's lakes and reservoirs have been the focus of much monitoring since Kemmerer and others visited the state early this century (Kemmerer et al. 1923). Milligan et al. (1983) have provided a bibliography of studies conducted before the mid-1980s. Since then, federal and state agencies, universities, industries and businesses, and public interest groups have committed funds and effort to investigating the resources of numerous waters. Most of these efforts have focused on traditional measures of trophic state, that is, the physical and chemical properties of water (Milligan et al. 1983; Falter and Hallock 1987; Kann and Falter 1987; Bellatty 1989a; 1989b; 1990; 1991; Breithaupt 1990; Entranco Engineers, Inc. 1990, 1992; Rothrock 1995; Idaho Department of Health and Welfare 1996; Montgomery Watson 1996). More recently, researchers have begun to incorporate biological monitoring of periphyton, aquatic macrophytes, benthic macroinvertebrates, and fish (Hoelscher et al. 1993; Mossier 1993; Lockhart 1995; Idaho Department of Health and Welfare 1997b; Rothrock and Mosier 1997).

A comprehensive review of data is important. It serves two purposes: eliminates collection of similar data that has been recently measured and provides a benchmark from which to evaluate temporal trends. This cost-effective step should be performed for each water body. As part of the "preplanning" process, the DEQ regional office contact should request available data from resources such as:

- Idaho Department of Fish and Game;
- Idaho Division of Health;
- Idaho Department of Water Resources (*e.g.* EDMS);
- U.S. Geological Survey;
- U.S. Environmental Protection Agency (*e.g.* STORET);
- U.S. Bureau of Land Management;
- U.S. Bureau of Reclamation;
- U.S. Natural Resource Conservation Service;
- U.S. Fish and Wildlife Service;
- U.S. Forest Service;
- tribal nations;
- universities; and
- hydropower companies.

This request should include any published reports and "gray" literature, raw data within ten years, Geographic Information System coverages, and other appropriate information relevant to selected measures.

Site Selection

Spatial
Lakes and reservoirs may exhibit distinct areas. Most lakes have a single basin and thus will consist of a single homogenous unit. Larger lakes may have basins and reservoirs may have zones that are morphologically or hydrologically different. Each lake basin and reservoir zone (flowing, river-like conditions; transitional conditions; and lacustrine, lake-like conditions near a dam) may be considered a separate unit. Additional basins and zones should be sampled if one site is insufficient to adequately characterize the physical, chemical, and biological characteristics of the water body. No more than three (3) sites per water body should be monitored.

Sites are thought of as samples of the larger homogenous unit and consist of pelagic, off-shore, and littoral, near-shore, stations. Pelagic stations will typically be located at the maximum depth. Representative stations may be more appropriate for reservoir riverine and transitional zones. Littoral stations will include one or more of four macrohabitat shorezones: a swimming area or boat launch, a major inlet, a representative least-affected shoreline, and a representative affected shoreline.

Temporal
Field sampling is scheduled in the period from mid-July through mid-September in order to obtain representative measures of lake and reservoir conditions during critical high temperature, maximum production, and high recreational use. The goal is to monitor each water body as close as possible to its annual peak biotic activity. A schedule was established to sample high-elevation and high-latitude lakes and reservoirs later and others with broader activity peaks sometime sooner.

Rationale for Selected Measures

Measures were selected based on relevant studies and personal experience with reference to the project goal. Many measures relate directly to beneficial uses, such as aquatic life and recreation. Others may be a surrogate when beneficial uses can not be measured directly. Minshall (1993) suggested using multiple measures because "it is unlikely that any one measure will have sufficient sensitivity to be useful in all circumstances."

Physical/Chemical

The physical and chemical environment is important to the support of biological communities. Each can be influenced by water body and surrounding features (*e.g.* depth, land use). Both can affect the structure and composition of biological communities.

Bathymetry or Depth

Water-basin morphology--or the area, depth, and shape of the water basin--influences water-body hydrodynamics and responses to pollution (Mortimer 1974). Morphology was the most important correlate among various biological assemblage taxa richness patterns and their environment features (Allen et al. 1998). While depth likely plays some role in holding down summer temperatures, its greatest effect seems to be in dilution capacity. Deep lakes are generally oligotrophic while shallow lakes tend to be eutrophic (Milligan et al. 1983; Bellatty 1989a, 1991; Mossier 1993; Lockhart 1995). Woods (1991) found nutrient concentrations increased with depth in Pend Oreille Lake, Idaho's deepest lake, which thereby acts as a sink. Mean depth has been related to hypolimnetic oxygen deficits (Cornett and Rigler 1979, 1980). It has been used with macrobenthic biomass to predict fish yield (Hanson and Leggett 1982). Mean depth and dissolved solids (morphoedaphic index) accurately predicted phytoplankton standing crop (Oglesby 1977a) and fish yield (Ryder et al. 1974; Oglesby 1977b).

Water Clarity

Secchi-disk measurement is a simple, effective, and widely-used method of determining water clarity. Clarity of water has been an important physical variable in determining trophic state (Carlson 1977; Milligan et al. 1983; Ryding and Rast 1989). The U.S. Environmental Protection Agency (1988) ranked it as one of the highest-priority measures in lake monitoring. Secchi-disk measurement is influenced by the absorption characteristics of water. It has been correlated to chlorophyll *a* (Carlson 1977; Mills and Schiavore, Jr. 1982) and is influenced by other factors such as turbidity and dissolved organic color. Chambers and Kalff (1985) reported the depth of light transmittance relates to maximum aquatic macrophyte depth. Mossier (1993) concurred the two were highly, positively correlated. Because of its relation to water clarity--a measure readily observed by users of water bodies--secchi-disk measurement is a good surrogate for the public's perception of water clarity.

Temperature

Water temperature is a commonly-used physical measure that has considerable chemical and biological significance. Essentially all aquatic plant and animal processes are temperature-dependent. Increased water temperatures are known to increase biological activity, and temperature can reach lethal limits for fishes (Smith 1982). The potential, or maximum, dissolved oxygen concentration is inversely proportional to water temperature (Wetzel 1983).

Temperature profiles are one of the highest-priority measures in lake monitoring (U.S. Environmental Protection Agency 1988). Identification of thermal stratification, a common characteristic of lakes, is often the emphasis of such profiles. In their simplest form, lake strata include a layer of warm, relatively light surface water (epilimnion) and a cold, dense layer on the bottom (hypolimnion) separated by a transition layer (metalimnion or thermocline) with a strong temperature gradient (equal to or greater than one degree Celsius per meter depth). The gradient prevents the epilimnion from circulating any deeper, thus isolating the hypolimnion waters from the water body's surface. The significance of stratification is that no exchange of dissolved constituents, such as gases or nutrients, is possible between the epilimnion and the hypolimnion. Organic material produced in the epilimnion settles into the hypolimnion and bottom sediments where it is decomposed during summer stratification. Dissolved oxygen is used in the decomposition and cannot be replenished, thus decreasing the amount of dissolved oxygen available to life in the water column.

Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life and is an important indicator of water-body health. It is a priority measure in lake monitoring (U.S. Environmental Protection Agency 1988). Much information can be obtained from this single measure. Water column dissolved oxygen concentrations determine which aquatic organisms will be able to exist. It is related to the photosynthetic activities of algae and aquatic macrophytes as well as to the decomposition of organic material. Dissolved oxygen gradients can supply insight into the mixing patterns of a water body and the extent of dissolved-oxygen deficits. Anoxic conditions can influence other chemical properties of water through the oxygen-reduction potential (Wetzel 1983).

Conductivity

Conductivity, or specific conductance, refers to the ability of water to conduct an electrical current. It is an indication of the concentration of dissolved solids. Kunkle et al. (1987) found conductivity to be an useful indicator of mining and agricultural effects. Royer and Minshall (1996) found waters designated as degraded generally had higher conductivities. Maret et al. (1997) reported conductivity is one environmental factor determining the distribution of fishes.

Hydrogen Ion Concentration (pH)

Hydrogen ion concentration, or pH, as with temperature, is an important regulator of many chemical and biological processes. The composition of aquatic communities is strongly influenced by pH (Marcus et al. 1986). The uptake and release rates of ions across gills, the primary method of ion regulation in aquatic animals, is at least partly pH-dependent (Smith 1982). Similarly, the toxicity of some chemicals is pH-dependent (Wetzel 1983).

Nutrients

Phosphorus and nitrogen are essential elements for plant growth. Excessive nutrients, however, can lead to eutrophication. This condition is termed "cultural" eutrophication when it is human-caused and has been found to be of concern to national waters (U.S. Environmental Protection Agency 1977). Heiskary and Walker (1988) reported excess nutrient concentrations resulted in aesthetic and "swimmability" problems. Nutrients have been used as an important chemical variable in determining trophic state (Vollenwieder 1976; Dillion and Rigler 1974; Carlson 1977; Milligan et al. 1983; Ryding and Rast 1989). Phosphorus has been found to be correlated to chlorophyll *a* concentration (Dillion and Rigler 1974; Carlson 1977; Oglesby 1997a; Lee and Jones 1984) and fish yield (Lee and Jones 1984; Hanson and Leggett 1982; Hoyer and Canfield 1991). Particulate inorganic phosphorus is adsorbed to soil particles and enters waters by sediment transport from the watershed, and is therefore an indication of land disturbance. Anoxic conditions can influence internal phosphorus "loading" (Wetzel 1983).

Shoreline Characterization

Water-level fluctuations can affect aquatic life. Jeppson (1954) and Bowler et al. (1979) found manipulation of water levels for hydroelectric power generation and flood control adversely affected kokanee *Oncorhynchus nerka* spawning and incubation in Pend Oreille Lake and its tributaries. Falter et al. (1992) speculated water-level fluctuation desiccated shallow areas and thus prohibited Eurasian water milfoil *Myriophyllum spicatum* var. *Spicatum*, an invasive aquatic macrophyte, in Pend Oreille Lake.

The presence and condition of riparian vegetation is important to the overall ecological health of a water body. Healthy vegetative stands provide biofiltration strips for sediment, nutrients and toxic substances; stabilize shorelines; sustain water levels; and provide essential habitat for aquatic-associated wildlife (Belt et al. 1992; Castelle et al. 1992).

Shoreline condition and material types correlate to erosion potential. Removal of vegetation reduces structural stability and negatively affects fish productivity (Platts and Nelson 1989; Platts 1990). Banks stabilized by deeply-rooted vegetation, rocks, logs, or other resistant materials are less susceptible to erosion (Bauer and Burton 1993).

Littoral Bottom Substrate

Sediment and its accumulation is detrimental to beneficial uses, particularly aquatic life and salmonid spawning. Fine sediment and availability of living space have direct affect on both fish and insects (Minshall 1984; Marcus et al. 1990). It limits the quality and quantity of the inter-gravel spaces that are critical for egg incubation (Scrivener and Brownlee 1989; Young et al. 1991; and Maret et al. 1993). Several studies and state projects have found relative substrate size to be important indicators of water quality effects due to activities in the watershed (Skille 1991; McIntyre 1993b; and Overton et al. 1993).

Diagrammatic Mapping and Photo Documentation
Diagrammatic mapping is a representative drawing of the water body. Mapping provides spatial information and an approximate scale of important characteristics such as land use, shoreline conditions, and habitat features (Meador et al. 1993). Such drawings compliment field notes and physical measures. Photographic records provide visual details of land use, shoreline characteristics, characteristics of littoral biological communities, et cetera. This type of documentation may also provide baseline information concerning qualitative changes.

Biological

Physical and chemical monitoring is not always representative of the long term water-quality condition because chemical constituents may vary temporarily. Biological monitoring provides an integrated representation of water-quality conditions because the biological community is exposed to the water's characteristics over a longer period of time.

Phytoplankton/Chlorophyll *a*
Phytoplankton is largely responsible for primary production in aquatic environments (Wetzel 1983). Virtually all dynamic features of water such as clarity (Carlson 1977; Mills and Schiavore, Jr. 1982), trophic state (Dillion and Rigler 1974; Carlson 1977; Milligan et al. 1983; Ryding and Rast 1989), zooplankton (Mills and Schiavore, Jr. 1982; Canfield and Watkins 1984), and fish production (Ryder et al. 1974; Oglesby 1997b; Jones and Hoyer 1982) depend to a large degree on the phytoplankton. Power et al. (1988) found beneficial uses can be affected by excess phytoplankton in lakes and slow-moving water bodies.

The quantity of phytoplankton indicates the degree of eutrophication. Chlorophyll *a* concentration is an often used surrogate measure for phytoplankton abundance (Carlson 1977; Milligan et al. 1983; Ryding and Rast 1989). Chlorophyll *a* concentration can be used to determine if elevated levels of critical nutrients are present (Dillion and Rigler 1974) and help determine the degree of degradation.

The quality, or speciation, of phytoplankton is equally as important. Many forms have different physiological requirements and vary in response to physical and chemical measures such as light, temperature, and nutrients. Mossier (1993) found blue-green algae were a significant and dominant part of the phytoplankton community for many eutrophic and mesotrophic lakes, while oligotrophic lakes showed no blue-green algae. Falter et al. (1992) noted the ascendancy of green and blue-green algae in Pend Oreille Lake was an indicator of increased pelagic productivity.

Benthic Macroinvertebrates

Benthic macroinvertebrates are one biological assemblage that reflects a water's overall ecological integrity. This biological assemblage is an useful assessment tool (Gerritsen and White 1997) because it is distributed widely, includes numerous species, and exhibits varying tolerances to physical and chemical changes in the water column and the sediment and water interface (Rosenberg and Resh 1993, David et al. 1998). Additionally, benthic macroinvertebrates with certain environmental tolerances may provide some insight of pollutants (St. Louis 1992, Johnson et al. 1993).

Zooplankton

A cost-effective surrogate to monitoring the fish community is to measure the zooplankton community. This approach is especially applicable for planktivorous fishes, *e.g.* kokanee, yellow perch *Perca flavescens*, and rainbow trout *Oncorhynchus mykiss* (Wallace 1982, Yule 1993). Mills and Schiavore, Jr. (1982) developed an index to predict the predator and prey balance in fish communities. Simply put, mean body length of crustacean zooplankton are equal to or greater than 1.0 mm in waters where predation is successfully controlling zooplankton density. The dominance of smaller zooplankton suggests an insufficient number of predators.

Periphyton

Periphyton is an useful indicator because of its wide distribution, numerous species, and rapid response to disturbance (U.S. Environmental Protection Agency 1996). Periphyton integrates physical and chemical effects. Diatoms, a type of periphyton, have frequently been identified as useful biological indicators particularly in Montana, Kentucky, Oklahoma, and European countries (Round 1991; Rosen 1995).

Aquatic Macrophytes

Aquatic macrophytes affect water quality through species presence and abundance. Mossier (1993) found the diversity of prevalent species generally demonstrated a two-fold increase from eutrophic to mesotrophic to oligotrophic lakes. Some natural systems have unacceptable conditions for aquatic macrophyte establishment due to depth (decreased light transmittance), turbidity, wave action, unstable substrate, and water level fluctuation (Falter et al. 1992). Coots and Carey (1991) measured mean oven dry weights of about two kilograms per squared meter in areas of nuisance aquatic macrophyte growth. Depending on the ecology of the system, aquatic macrophytes may typically provide food (in the form of detritus) and shelter. In ecologically unstable conditions, however, aquatic macrophytes may produce dense mats that are aesthetically objectionable (Coots and Carey 1991; Allen 1995) and reduce fish yield (Coots and Carey 1991). Consequently, aquatic macrophytes are an important component of the biological community. Some indices have been developed and used in other bioassessments (Lockhart 1995; Small et al. 1996).

Water-Column Pathogen
The State of Idaho has set water-quality standards to protect recreational beneficial uses through numerical *Escheririchia coli* criteria (Idaho Department of Health and Welfare 2000). These criteria are protective of immersion in water and recreation on the water.

Fish
Fish contribute significantly to the ecology of the aquatic community. This biological assemblage is highly visible to the public and is an important economic resource in Idaho. Additionally, fish have relatively long life spans that can reflect long term and current water- quality conditions. Due to their mobility, fish also have extensive ranges and may be useful for evaluating regional and large habitat differences (Simon and Lyons 1995).

Method

Methods may have been modified from their original citation. Modifications are necessary so measures are taken consistently statewide to obtain reliable and comparable data.

Descriptions

Table 1 lists the measures, method references, and levels of intensity. Pelagic stations will be located at the maximum depth. Representative stations may be more appropriate for reservoir riverine and transitional zones. Littoral stations will include one or more of four macrohabitat shorezones: a swimming area or boat launch, a major inlet, a representative least-affected shoreline, and a representative affected shoreline.

Bathymetry or Depth
Locate multiple transects representing a grid pattern to generate a depth-contour map of the water body. Map the grid with directional arrows on a diagram of the water body. Record the latitude and longitude using a Global Positioning System and compass heading of your position at the beginning of each transect. Measure maximum depth using a fathometer at regular intervals along each transect. Regular intervals are determined by set intervals on a stop watch. Record your position using a Global Positioning System at the end of each transect.

Water Clarity
Locate pelagic stations. Take Secchi-disk readings without sunglasses and with the sun to the observers back. Lower the Secchi disk into the water and note the depth at which it disappears. Lower the disk a little further and slowly raise the disk. Note the depth at which it reappears. Average the two depths and record the measure as the Secchi-disk depth.

Table 1. Lake and reservoir Beneficial Use Reconnaissance Project measures, method references, and levels of intensity in 2000.

Measures	Method Reference	Level of Intensity
Bathymetry or Depth	Hamilton and Bergersen 1984	Measure maximum depth at regular intervals along evenly-spaced transects.
Water Clarity	Hamilton and Bergersen 1984	Measure Secchi-disk depth at pelagic stations.
Temperature	Woods 1991	Measure depth profile at pelagic stations.
Dissolved Oxygen	Woods 1991	Measure depth profile at pelagic stations.
Conductivity	Woods 1991	Measure depth profile at pelagic stations.
Hydrogen Ion Concentration (pH)	Woods 1991	Measure depth profile at pelagic stations.
Phytoplankton/ Chlorophyll *a*	Bellatty 1990	Collect water samples at pelagic stations. Composite water samples from five equally-spaced depth intervals, one immediately below the surface, in the euphotic zone (2.5 x Secchi-disk depth) of stratified waters or throughout the water column in unstratified waters.
Nutrients	Bellatty 1990	Collect water samples at pelagic stations. Composite water samples from five equally-spaced depth intervals, one immediately below the surface, in the euphotic zone (2.5 x Secchi-disk depth) of stratified waters or throughout the water column in unstratified waters. Composite two water samples from one meter off of the bottom.
Zooplankton	Smith (1998)	Collect a vertical tow at pelagic stations. Tows are taken in the euphotic zone (2.5 x Secchi-disk depth) of stratified waters or from two meters off of the bottom in unstratified waters.

Measures	**Method Reference**	**Level of Intensity**
Diagrammatic Mapping and Photo Documentation	U.S. Environmental Protection Agency 1997	Map bathymetry or depth transects, pelagic stations and macrohabitat shorezones, and areal coverage of each macrohabitat shorezone. Take photographs of each macrohabitat shorezone, in the littoral zone at each macrohabitat shorezone, and aquatic macrophytes per lake basin or reservoir zone.
Benthic Macroinvertebrates	Kinney et al. 1997	Collect grab samples from the soft substrata in the sublittoral zone or 2.5 x Secchi-disk depth at a representative macrohabitat shorezone per lake basin or reservoir zone.
Shoreline Characterization	Kaufman and Whittier 1997	Record characteristics of each macrohabitat shorezone per lake basin or reservoir zone.
Littoral Bottom Substrate	Kaufman and Whittier 1997	Record the dominant substrate size of each macrohabitat shorezone per lake basin or reservoir zone.
Periphyton	Kaufman and Whittier 1997	Describe community growth and form of each macrohabitat shorezone per lake basin or reservoir zone.
Aquatic Macrophytes	Mossier 1993; Kaufman and Whittier 1997	Collect aquatic macrophytes along a horizontal "rake." Describe community growth and form and percent coverage of each macrohabitat shorezone per lake basin or reservoir zone.
Water-Column Pathogen	Franson 1998	Collect sample(s) at either a swimming area or boat launch macrohabitat shorezone. Coordinate with the DEQ Regional Office or other appropriate agency.
Fish	Not Applicable	Use existing data. Coordinate collection with the appropriate agency.

Temperature, Dissolved Oxygen, Conductivity, and Hydrogen Ion Concentration (pH)
Measure temperature, dissolved oxygen, conductivity, and pH using a Hydrolab® or other similar multi-measure probe. Record at one meter depth intervals to 20 m depth and then at five meter depth intervals thereafter. Make an additional measurement at one meter off of the bottom in waters greater than 20 m and less than 50 m deep.

Phytoplankton/Chlorophyll *a*
In stratified waters, composite five 2.2 L Van Dorn (or other similar horizontal bottle) samples taken at equally-spaced depth intervals in the euphotic zone (2.5 x Secchi-disk depth), one immediately below the surface. In unstratified waters, composite five 2.2 L Van Dorn bottle samples taken at equally-spaced depth intervals throughout the water column, one immediately below the surface. Mix samples thoroughly in a 14 L polyeurethane container. Filter a 500-1000 ml sub-sample using a 0.7 μm glass fiber filter and a hand-operated vacuum filter apparatus at 20-30 psi under a boat canopy. Add 0.5 ml of magnesium carbonate with 10 ml filtrate left. Place filter in petri dish; wrap in aluminum foil; label with site identification number, station, and date; and chill to four degrees Celsius. Freeze in the laboratory for later identification.

Draw a 250 ml sub-sample into an amber polyeurethane bottle. Fix with about two to three ml Lugol's solution or until "tea-colored." Label with site identification number, station, and date and chill to four degrees Celsius.

Nutrients
In stratified waters, composite five 2.2 L Van Dorn (or other similar horizontal bottle) samples taken at equally-spaced depth intervals in the euphotic zone (2.5 x Secchi-disk depth), one immediately below the surface. In unstratified waters, composite five 2.2 L Van Dorn bottle samples taken at equally-spaced depth intervals throughout the water column, one immediately below the surface. Mix the samples thoroughly in a 14 L polyeurethane container. Rinse a one liter cubitainer and lid twice with sample water. Draw a one liter sub-sample preserved with two milliliters of concentrated sulfuric acid. Label with site identification number, station, depth (*e.g.* shallow), and date and chill to four degrees Celsius.

Repeat the process with two 2.2 L Van Dorn bottle samples taken one meter off of the bottom. Label with site identification number, station, depth (*e.g.* deep), and date and chill to four degrees Celsius.

Zooplankton
Collect a vertical tow through the euphotic zone (2.5 x Secchi-disk depth) in stratified waters or from two meters off of the bottom in unstratified waters using a 80 μm mesh Wisconsin-style plankton net. Tow the net using a "hand-over-hand" technique at about one meter per second

rate. Wash contents down the net by splashing sample water from the outside of the net in. Detach the collection bucket and partially immerse in chilled 95% ethanol. Care should be taken not to spill ethanol over the top of the collection bucket. Wash the contents into a sample container, label inside and outside with a label marked in either an alcohol-proof pen or pencil, and preserve with 70% ethanol.

Diagrammatic Mapping and Photo Documentation
Diagrammatically map the bathymetric transects with directional arrows, pelagic stations, benthic macroinvertebrate sampling stations, macrohabitat shorezones and areal coverage, and shoreline and in-lake codes. Take a photograph of each macrohabitat shorezone. Photograph the littoral zone assessment at one, two, and three meters distance from shore at three evenly-spaced transects perpendicular to the shore in a 150 m horizontal macrohabitat shorezone using an underwater viewbox. Photograph a representative sub-sample of the aquatic macrophyte "rake" in a white dissecting pan.

Benthic Macroinvertebrates
Collect three replicate Petite ponar dredges at a representative macrohabitat shorezone per lake basin or reservoir zone. Samples should be collected from soft substrata in the sublittoral zone or 2.5 x Secchi-disk depth. Sieve the samples through a standard 500 μm screen. Place the sample into a container, label inside and outside with a label marked in either an alcohol-proof pen or pencil, and preserve with 70% ethanol. Contents should be divided into two sample containers if the container is more than one-half full of sample material.

Shoreline Characterization
Record the water-level fluctuation, riparian vegetation width, percent riparian vegetative cover, shoreline substrate, and human influences for each macrohabitat shorezone per lake basin or reservoir zone. Noting dominant (>50%) riparian vegetation (*e.g.* trees, willows, grass) or alternate shoreline stabilization (*e.g.* rip-rap, car bodies) is encouraged.

Littoral Bottom Substrate
Record the dominant (>50%) littoral bottom substrate at one, two, and three meters distance from shore at three evenly-spaced transects perpendicular to the shore in a 150 m horizontal macrohabitat shorezone per lake basin or reservoir zone. An underwater viewbox may be used to facilitate observations.

Periphyton
Describe the periphyton community's growth and form at one, two, and three meters distance from shore at three evenly-spaced transects in a 150 m horizontal macrohabitat shorezone per lake basin or reservoir zone. An underwater viewbox may be used to facilitate observations.

Aquatic Macrophytes

Describe the aquatic macrophyte community's growth and form at one, two, and three meters distance from shore at three evenly-spaced transects in a 150 m horizontal macrohabitat shorezone per lake basin or reservoir zone. An underwater viewbox may be used to facilitate observations. Record the percent areal coverage.

Drag a weighted rake five meters along a two meter depth contour at either a swimming area or boat launch macrohabitat shorezone per lake basin or reservoir zone. Dunk-wash the sample in a mesh bag and drain, wet weigh the sample, estimate the possible number of species, photograph a representative sample in a white dissecting pan, and chill to four degrees Celsius in Ziploc© bags. Freeze in the laboratory for later identification.

Water-Column Pathogen

Collect a water sample from a swimming area or boat launch macrohabitat shorezone in a 250 ml sterile milk dilution bottle pre-rinsed with sodium thiosulfate. Chill to four degrees Celsius and delivery to the State of Idaho Bureau of Laboratories with 24 h.

All lakes and reservoirs are assumed to support whole-body immersion. If the applicable standard (406 organisms per 100 ml) is exceeded, collect five additional samples within a 30 d period.

Recommended Procedural Sequence for Water Body Evaluation

The lake and reservoir field equipment needed for collecting the information are listed in Appendix II. The forms for recording the information are provided in Appendix III.

- Conduct pre-monitoring steps to gather all existing physical, chemical, and biological data. Coordinate monitoring efforts (*e.g.* water-column pathogen and fish) with federal, state, and local governmental agencies or entities.

- Generate a bathymetric map if none exists. (This is very time consuming, so making exhaustive efforts to find existing maps is highly recommended.) Survey for appropriate pelagic stations and macrohabitat shorezones and map the areal extent of macrohabitat shorezones and shoreline and in-lake codes while recording depths or if a bathymetric map already exists.

- Select the maximum depth or representative reservoir riverine or transitional pelagic station. Anchor the boat.

- Record the latitude and longitude of the location.

- Measure Secchi-disk depth.

- Record water-quality measure depth profiles with the Hydrolab® or other similar multi-measure probe.

- Identify the top and bottom of the thermocline.

- Collect five water samples from throughout the euphotic zone (2.5 x Secchi-disk depth) in stratified waters or from throughout the water column in unstratified waters. Filter a 500-1000 ml sub-sample for chlorophyll *a*. Draw a 250 ml sub-sample for phytoplankton speciation. Rinse a one liter cubitainer twice and draw and preserve a sub-sample for nutrients. Label all samples appropriately. Chill to four degrees Celsius.

- Collect two water samples from one meter off of the bottom. Rinse a one liter cubitainer twice and draw and preserve a sub-sample for nutrients. Label appropriately and chill to four degrees Celsius.

- Collect a vertical tow throughout the euphotic zone (2.5 x Secchi-disk depth) in stratified waters or from two meters off of the bottom in unstratified waters with a Wisconsin-style zooplankton net. Immerse collection bucket in 95% ethanol. Label and preserve (70% ethanol) the sample.

- Select and map a representative sublittoral (2.5 x Secchi-disk depth) location for benthic macroinvertebrate sampling. Collect three replicates, seive, label, and preserve with 70% ethanol.

- Select and photograph appropriate macrohabitat shorezones. Complete shoreline characterization. Describe the littoral bottom substrate and the periphyton and aquatic macrophyte communities. Record the percent aquatic macrophyte coverage. Collect an aquatic macrophyte "rake", dunk-wash and drain the sample, wet-weigh, and photograph a representative sub-sample at either a swimming area or boat launch macrohabitat shorezone. Chill the sample in Ziploc© bags and freeze in the laboratory. Record the possible number of aquatic macrophyte species.

- Repeat the preceding steps at all lake basins or reservoir zones stations.

- Complete any additional coordinated monitoring (*e.g.* water-column pathogen, fish).

Quality Control and Quality Assurance

Quality control and quality assurance are cornerstones of any high-quality product or service. They ensure consistent, precise, and accurate data. Tasks related to field application of this protocol that enhance data reliability are: field crew training; field crew supervision; equipment maintenance and calibration; sample duplicates and blanks; and auditing of the field crew. These are discussed in more detail in *Beneficial Use Reconnaissance Project Quality Control and Quality Assurance Manual for Lakes and Reservoirs* (Hoelscher 2000).

Field Crew Training

The DEQ provides field crew training covering all aspects of the work plan. Training provides hands-on experience in each measure for each field crew member. Training requires a minimum of two days: one day in the classroom and one day in the field. Lake and reservoir BURP protocol may require additional skills such as boat and trailer handling.

All individuals involved in the field collection of the BURP data will be trained and certified in cardio-pulmonary resuscitation. This requirement will increase field safety. The individuals may be trained by the DEQ "in-house" or certification can be a hiring requirement.

Field Crew Supervision

The field crew is supervised throughout the monitoring season. The DEQ will occasionally (biweekly as time allows) accompany the crew in the field. Additionally, the DEQ provides weekly meetings before leaving for the field.

Equipment Maintenance and Calibration

Field

All sampling equipment (*e.g.* bottles, nets) and other items that have come in contact with a sample and have the potential to contaminate other measures must be carefully examined and cleaned of any material after sampling is completed at any site. All equipment should be examined again prior to use at the next site and recleaned if needed.

Laboratory

All sampling equipment must be maintained and calibrated following the manufacturer's recommended procedures. Maintenance and calibration information (*e.g.* procedures and standards) will be recorded weekly in a log.

Some measures are to be completed by parties other than the field crew. Maintenance and calibration will be regularly performed as recommended in operations manuals and as part of contractual requirements.

Sample Duplicates and Blanks

Duplicates and blanks will be collected on ten percent of the water bodies. These are to test the laboratory's precision and potential field contamination. Duplicates are as the name implies with another sample collected following this protocol. These will be collected for phytoplankton, chlorophyll *a*, nutrients, zooplankton, benthic macroinvertebrates, and water-column pathogens. Blanks will be collected for chlorophyll *a*, nutrients, and water-column pathogens. The chlorophyll *a* blank is collected by filtering one liter of de-ionized water in the field. The nutrient blank is one liter of de-ionized water collected and fixed in the field.

The regional office contact will perform the water-column pathogen duplicates and blanks in concert with their sample collection. This is performed similarly to the wadable stream protocol (Beneficial Use Reconnaissance Project Technical Advisory Committee 1999). A blank sample container and laboratory prepared blank water accompanies the empty sample container into the field. The blank is opened for a few seconds and is filled with the laboratory prepared water, stored, and transported similarly to the other samples.

Auditing Field Crew

A field audit consists of the DEQ observing the field crew performing measures and collecting samples from a water body. An audit is scheduled to occur within the first two weeks of field crew training. Each crew will have at least one audit.

Audit findings will be discussed with the field crew. Additional training will be required if the auditor observes deviations from the work plan. The level of additional training will be dictated by the significance of the deviation. It will be determined whether the deviation is likely to result in unacceptable data. Appropriate steps will then be taken.

Human Influences

Waters naturally become more eutrophic. This concept is termed cultural eutrophication when it is human-caused. Table 2 lists probable human influences that may predictably change water-quality measures.

Table 2. Criteria and guidance for evaluating human influences for Idaho's lake and reservoir Beneficial Use Reconnaissance Project.

Criteria	Guidance
Riparian Vegetation	The amount of the water body perimeter sustaining a vigorous, effective, riparian buffer. Vigor is defined as a mature, complex, vegetative stand. An effective buffer is defined as capable of minimizing effects from human influences.
Point-Source Discharge(s)	The quantity (both in number and volume) of point source discharges. A point-source discharge is defined as a discrete conveyance (*e.g.* pipe, agriculture return-flow). A point-source discharge upstream of a receiving water body is not considered if the potential effects of that discharge have the capability of dissipating, *e.g.* settling in an upstream basin.
Water-Level Fluctuation	The maximum vertical water-level fluctuation evident. Low likely does not negatively affect biological communities.
Recreational Development and Use	Acreage with campgrounds, day-use areas, parking, and boat ramps within one mile of the water body. Number of recreational-user days compared to other waters.
Perimeter Home Development	The amount of the water body perimeter within one mile of the water body developed.
Substandard Septic Density	Most of the drain fields do not meet public health standards. This may be evaluated by persistent public health risks.
Perimeter Road Density	The amount of the water body perimeter in roads constraining the riparian zone or indicating road-associated affects. Riparian zone will be considered within 1000 ft of the water body.
Agricultural/Grazing Use	The amount of the immediate watershed grazed or in cropland vegetation, including fertilized hay.
Silvicultural Use	The amount of the immediate watershed in unimproved roads or equivalent clearcut acres.
Mining Use	The amount of the immediate watershed affected by mining related activities.

Human influences will be evaluated by both regional resources managers and the field crew. Evaluation may require a visit to the water body. Guidance as published in Table 2 should be used to rate the level of human influence as either low, moderate, or high. Extreme affects should be noted.

Data Handling and Storage

Proper labeling and field documentation are conducted to demonstrate compliance with sampling protocol and to reduce misidentification of samples. A chain of custody is given to the receiving laboratory to assure proper sample transfer.

The DEQ will annually audit field forms for completeness, accuracy, and consistency following procedures identified in *Beneficial Use Reconnaissance Project Quality Control and Quality Assurance Manual for Lakes and Reservoirs* (Hoelscher 2000). Sample processing outside of the DEQ will be addressed in appropriate "request for proposals" and subsequent contracts.

Voucher specimens of all organisms collected are stored in glass vials of 70% ethanol (Clark and Gregg 1986) with proper locality, date, collector, and determination labels. These specimens are then available for any later verification that might be needed and for future research opportunities. The specimens are deposited in the Orma J. Smith Museum of Natural History, Albertson College of Idaho, Caldwell.

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Glossary

aquatic macrophyte - The larger, non-microscopic aquatic plants found in the littoral zone of lakes and streams.

beneficial use - Any of the various uses that may be made of water, including, but not limited to, water supply (agricultural, domestic, or industrial), recreation in or on the water, aquatic life, wildlife habitat, and aesthetics.

chlorophyll *a* - The dominant green, photosynthetic pigment in plants. A measure of aquatic plant production.

criteria - Either a narrative or numerical statement of water quality on which to base judgement of suitability for beneficial use.

designated use - A beneficial use listed for a water body or water bodies in a state's water quality regulations.

euphotic zone - The depth to which one percent of incident light penetrates. The lighted zone of a water body.

eutrophic - Literally "nutrient rich"; generally refers to a fertile, productive water body. Contrasts with oligotrophic.

eutrophication - The process of nutrient enrichment in aquatic systems, such that the productivity of the system is no longer limited by the availability of nutrients. This is a natural process but may be accelerated by human activities.

existing use - A beneficial use actually attained by a water body on or after November 28, 1975.

integrity - The extent to which all parts or elements of a system (e.g. aquatic ecosystem) are present and functioning.

lentic - Pertaining to standing waters (*e.g.* ponds, lakes, reservoirs).

littoral zone - The region along the lake or reservoir shore extending lakeward to the greatest depth occupied by rooted aquatic plants.

oligotrophic - Literally "nutrient poor"; generally refers to an infertile, unproductive water body. Contrasts with eutrophic.

pelagic - Referring to the open area of a lake or reservoir; from the littoral zone to the center of the water body.

phytoplankton - Aquatic plants, usually microscopic; sometimes consisting of a single cell.

pollution - Any alteration in the character or quality of the environment due to human activity that makes it unfit or less suited for beneficial uses.

reconnaissance - An exploratory or preliminary survey of an area.

reference conditions - Conditions that fully support beneficial uses; with little impact from human activity and representing the highest level of support attainable.

stratification - The forming or arrangement of layers. This is usually caused by differences in temperature and density between layers.

sublittoral - Referring to the deeper part of the littoral zone of a water body.

thermocline - Represented by the reduction in water temperature of one degree Celsius or greater.

trophic status - Referring to the nourishment status of a water body; *e.g.* eutrophic, oligotrophic.

water body - A specific body of water or geographically delimited portion thereof.

water quality -A term for the combined chemical, physical, and biological characteristics of water that affect its suitability for beneficial use.

zooplankton - Small invertebrate animals suspended in and passively drifting through the water column and insect larvae.

Appendix I. Lakes and Reservoirs Scheduled for Sampling in 2000

Water Body Name	Hydrologic Unit Code	Water Body Identification Number
Ashton Reservoir	17040202	US-1
Blanchard Lake	17010214	P-8
Brownlee Reservoir	17050201	SW-3
Cave Lake		
Chase Lake	17010215	P-7
Chatcolet Lake	17010304	P-1
Chesterfield Reservoir	17040208	US-19
Dawson Lake		
Fish Creek Reservoir	17040221	US-7
Gamble Lake	17010214	P-19
Henrys Lake	17040202	US-35
Horsethief Reservoir	17050123	SW-5
Kelso Lake	17010214	P-4
Lake Lowell	17050114	SW-4
Lost Valley Reservoir	17050124	SW-19
Lower Granite Reservoir	17060306	C-1
Mackay Reservoir	17040218	US-12
Mann Creek Reservoir	17050124	SW-31
McArthur Lake	17010104	P-23

Water Body Name	Hydrologic Unit Code	Water Body Identification Number
Mirror Lake	17010214	P-20
Mormon Reservoir	17040220	US-23
Payette Lake	17050123	SW-17
Perkins Lake	17010104	P-35
Redfish Lake	17060201	S-63
Robinson Lake	17010105	P-9
Rose Lake	17010303	P-21
Round Lake	17010214	P-12
Salmon Falls Creek Reservoir	17040213	US-7
Shepard Lake	17010214	P-17
Soldiers Meadow Reservoir	17060306	C-7
Upper Priest Lake	17010215	P-16

Appendix II. Lake and Reservoir Beneficial Use Reconnaissance Project Field Equipment Check List per Water Body

Equipment Description	Quantity	Yes	No
General Equipment			
boat	1		
fire extinguisher/horn	1		
life vest	3		
gas/oil/grease	QAN		
boat paddle	1		
anchor/rope wheel	1		
plastic bucket	1		
aluminum form holder	1		
field form	2		
Bathymetry or Depth Equipment			
Global Positioning System	1		
compass	1		
fathometer	1		
stop watch	1		
Water Clarity Equipment			
Secchi disk	1		
Temperature, Dissolved Oxygen, Conductivity, Hydrogen Ion Concentration (pH)			
Hydrolab®	1		
laptop computer	1		

Equipment Description	Quantity	Yes	No
Phytoplankton/Chlorophyll *a* Equipment			
2.2-L Van Dorn bottle	1		
14-L churnsplitter	1		
hand-operated vacuum pump filter apparatus	1		
4-L de-ionized water	1		
0.7 μm glass fiber filter	4		
filter forcep	1		
50-ml magnesium carbonate	1		
petri dish	3		
aluminum foil	1		
250-ml brown polyethylene bottle	3		
10-ml Lugol's iodine solution	1		
indelible marker	1		
cooler	1		
ice	QAN		
Nutrients			
2.2-L Van Dorn bottle	1		
14-L churnsplitter	1		
1-L cubitainer	8		
4-L de-ionized water	1		
2-ml ampule concentrated sulfuric acid	8		
indelible marker	1		
cooler	1		

Equipment Description	Quantity	Yes	No
ice	QAN		
Zooplankton Equipment			
Wisconsin net	1		
500-ml squirt bottle (70% ethanol)	1		
immersion bath (95% ethanol)	1		
sample containers	3		
3-L preservative (70% ethanol)	1		
field label	6		
indelible, alcohol-proof marker	1		
Diagrammatic Mapping and Photo Documentation Equipment			
dry-erase board/markers	1		
camera	1		
film (200 ASA)	120 exp.		
Benthic Macroinvertebrate Equipment			
Petite Ponar dredge	1		
500-μm seive bucket	1		
sample container	6		
500-ml squirt bottle (70% ethanol)	1		
6-L preservative (70% ethanol)	1		
forcep	1		
field label	12		
indelible, alcohol-proof marker	1		

Equipment Description	Quantity	Yes	No
Shoreline Physical Habitat Characterization Equipment			
100-m tape measure	1		
Littoral Bottom Substrate Equipment			
100-m tape measure	1		
viewbox	1		
Periphyton Equipment			
100-m tape measure	1		
viewbox	1		
Aquatic Macrophyte Equipment			
100-m tape measure	1		
viewbox	1		
rake	1		
mesh wash bag	1		
10-kg Pescola spring scale	1		
white dissecting pan	1		
4-L Ziploc© bag	6		
indelible marker	1		
cooler	1		
ice	QAN		

QAN Quantity As Needed

Appendix III. Lake and Reservoir Field Forms

2000 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Department of Environmental Quality

Water Body Identification

Name: ____________ Site ID: 2000 Q ____ Date (YY/MM/DD): 00/ / ____

Water Body Location

HUC: ____________ WB ID No.: ____________ Map Elevation (ft or m): ____________

County(s): ____________ Ecoregion: ____________

Water Body Characteristics

Dam Height (ft or m): ____________ Maximum Width Perpendicular to Flow (mi or km): ____________

Watershed Size (sq mi or sq km): ____________ Water Body Size (sq mi or sq km): ____________

Relief (circle one): low moderate high Water Body Orientation: ____________ Fetch (mi or km): ____________

Weather Conditions (circle one per descriptor):

Light Intensity	Sunny	Partly Cloudy	Mostly Cloudy	Cloudy
Relative Wind Speed	Calm	Breezy	Windy	Very Windy/Gail Force
Intensity of Precipitation	Dry	Light Rain	Moderate Rain	Hard Rain/Downpour

Surface Conditions (circle one): Flat Ripples Choppy Whitecaps

Crew: ____________

Water Body Uses/Influences

Observed Uses (circle all that apply): Swimming Boating Fishing Livestock Hydropower Other: ____________

Human Influences (circle one):

Riparian Vegetation	L	M	H	Substandard Septic Density	L	M	H
Point-Source Discharge(s)	L	M	H	Perimeter Road Density	L	M	H
Water-Level Fluctuation	L	M	H	Agricultural/Grazing Use	L	M	H
Recreational Development and Use	L	M	H	Silvicultural Use	L	M	H
Perimeter Home Density	L	M	H	Mining Use	L	M	H

Comments: ____________

2000 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Department of Environmental Quality

Name: ______________________ Site ID: 2000 Q ______ Date (YY/MM/DD): 00/ / ______

Detailed Drawing of Water Body

Shoreline and in-lake codes: FST=forest; LGG=logging; MNG=mining; GRZ=grazing; PTR=pasture; FLT=feedlot; CRP=cropland; IND=industry; HPR=hydropower; LHD=lowhead dam; DVN=diversion; RDS=roads; BDG=bridge; URB=urban; RSO=residence; LFL=landfill/dump; DWS=domestic water supply; SWR=stormwater outfall; WTR=wastewater outfall; BCH = beach; PRK = park; RST=resort; CMP=campground; PNC=picnic; LDS=landslide; SLP=slump/mass wasting; ERO=erosion; ALT=altered shoreline; SHL=shoal/rocks; RMP=boat ramp; DCK=dock; MNA=marina; WET=wetland; FLM=floating macrophytes; SBM=submerged macrophytes; EMM=emergent macrophytes; _______=

2000 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Department of Environmental Quality

Name: ____________________ Site ID: 2000 Q ____________ Date (YY/MM/DD): 00/ / ______

START	Transect __	Transect __	Transect __	Transect __	Transect __
Latitude (ddmmss):					
Longitude (ddmmss):					
Compass Heading:					
Maximum Depth (ft or m):					
STOP					
Latitude (ddmmss):					
Longitude (ddmmss):					

2000 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Department of Environmental Quality

Name: ______________________ Site ID: 2000 Q ______ Date (YY/MM/DD): 00/ / ______

START	Transect __	Transect __	Transect __	Transect __	Transect __
Latitude (ddmmss):					
Longitude (ddmmss):					
Compass Heading:					
Maximum Depth (ft or m):					
STOP					
Latitude (ddmmss):					
Longitude (ddmmss):					

Name: ______________________ Site ID: 2000 Q ______ Date (YY/MM/DD): 00/ / ______

Pelagic Station Location

Latitude (ddmmss): ______________ Longitude (ddmmss): ______________

Location Description: ______________________________

Water-Quality Depth Profiles

Maximum Depth (ft or m): ________ Secchi Depth (m): ________ Hydrolab Filename: ________

Depth (m)	Temp. (C)	DO (ppm)	Conductivity	pH	Depth (m)	Temp. (C)	DO (ppm)	Conductivity	pH
1					14				
2					15				
3					16				
4					17				
5					18				
6					19				
7					20				
8					25				
9					30				
10					35				
11					40				
12					45				
13					50				
Indicate top (T) and bottom (B) of thermocline					Indicate top (T) and bottom (B) of thermocline				

Comments: ______________________________

Name: ______________________ Site ID: 2000 Q ________ Date (YY/MM/DD): 00/ / ______

Pelagic Station Location

Latitude (ddmmss): ____________ Longitude (ddmmss): ____________

Location Description: ______________________

Chlorophyll a

Sample Volume Filtered (ml): ________ Duplicate Volume Filtered (ml): ________ Blank Volume Filtered (ml): ________

Comments: ______________________

Phytoplankton

Comments: ______________________

Nutrients

Comments: ______________________

Zooplankton

Comments: ______________________

Benthic Macroinvertebrate Sample Location

Latitude (ddmmss): ____________ Longitude (ddmmss): ____________

Location Description: ______________________

Comments: ______________________

2000 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Department of Environmental Quality

Name: ______________________ Site ID: 2000 Q ________ Date (YY/MM/DD): 00/ / ________

Associated Pelagic Station Description: ______________________

Shoreline Characterization

	Macrohabitat Shorezones			
	Swimming/Boating	Major Inlet	Least Affected	Affected
Present Water-Level Fluctuation (m):				
Riparian Vegetation Width (m):				
Percent Riparian Vegetation: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%)				
Dominant Shoreline Substrate: vegetated=VG, fine soil/sediment=FS (0-1 mm), sand=SA (1-2.5 mm), gravel=GV (2.5-64mm), cobble=CO (64-256 mm), boulder=BO (> 256mm), bedrock=BR				
Human Influences (indicate all that apply):				
Forestry				
Mining				
Agriculture				
Grazing				
Roads				
Urban/Residential				
Recreation				
Hydropower/Diversion				
Other ______________				

Name: ________ ______________________________ Site ID: 2000 Q Date (YY/MM/DD): 00/ /

Associated Pelagic Station Description: ______________________________

Littoral zone

	Meters from shore	Macrohabitat Shorezone Transects											
		Swimming/Boating			Major Inlet			Least Affected			Affected		
		1	2	3	1	2	3	1	2	3	1	2	3
Littoral Bottom Substrate Indicate dominant substrate. vegetated=VG; fine soil/sediment=FS (0-1 mm), sand=SA (1-2.5mm), gravel=GV (2.5-64mm), cobble=CO (64-256mm), boulder=BO (> 256mm), bedrock=BR	1												
	2												
	3												
Periphyton Each entry should consist of a growth and form code. Growth: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%) Form: filamentous=FT, pin cushion=PC, gelatinous=GL	1												
	2												
	3												
Aquatic Macrophytes Each entry should consist of a growth and form code. Growth: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%) Form: short stature=SS, stems visible not reaching surface=SV, stems overlapping surface=SO, floating=FL	1												
	2												
	3												
Percent Aquatic Macrophyte Coverage:													
Number of Possible Aquatic Macrophyte Species:					**Aquatic Macrophyte Wet Weight (kg):**								

2000 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Department of Environmental Quality

Name: ______________________ Site ID: 2000 Q ______ Date (YY/MM/DD): 00/ / ____

Associated Pelagic Station Description: ______________________

Photograph Information

Roll (name or number): ______________________

Circle All That Apply:

Photo #: ____	Swimming/Boating		Major Inlet		Least Affected		Affected		
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	Swimming/Boating		Major Inlet		Least Affected		Affected		
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M

Circle All That Apply:

Photo #: ____	Swimming/Boating		Major Inlet		Least Affected		Affected		
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	Swimming/Boating		Major Inlet		Least Affected		Affected		
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M

2000 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Department of Environmental Quality

Name: ____________________ Site ID: 2000 Q ______ Date (YY/MM/DD): 00/ / ______

Additional Information

2000 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Department of Environmental Quality

Name: ______________________ Site ID: 2000 Q ______ Date (YY/MM/DD): 00/ / ______

Pelagic Station Location

Latitude (ddmmss): ______________ Longitude (ddmmss): ______________

Location Description: ______________________

Water-Quality Depth Profiles

Maximum Depth (ft or m): ________ Secchi Depth (m): ________ Hydrolab Filename: ________

Depth (m)	Temp. (C)	DO (ppm)	Conductivity	pH	Depth (m)	Temp. (C)	DO (ppm)	Conductivity	pH
1					14				
2					15				
3					16				
4					17				
5					18				
6					19				
7					20				
8					25				
9					30				
10					35				
11					40				
12					45				
13					50				
Indicate top (T) and bottom (B) of thermocline					Indicate top (T) and bottom (B) of thermocline				

Comments: ______________________

2000 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Department of Environmental Quality

Name: ______________________ Site ID: 2000 Q ____________ Date (YY/MM/DD): 00/ / ________

Pelagic Station Location

Latitude (ddmmss): ______________ Longitude (ddmmss): ______________

Location Description: ______________________________

Chlorophyll a

Sample Volume Filtered (ml): ________ Duplicate Volume Filtered (ml): ________ Blank Volume Filtered (ml): ________

Comments: ______________________________

Phytoplankton

Comments: ______________________________

Nutrients

Comments: ______________________________

Zooplankton

Comments: ______________________________

Benthic Macroinvertebrate Sample Location

Latitude (ddmmss): ______________ Longitude (ddmmss): ______________

Location Description: ______________________________

Comments: ______________________________

2000 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Department of Environmental Quality

Name: ______________________ Site ID: 2000 Q ______ Date (YY/MM/DD): 00/ / ______

Associated Pelagic Station Description: ______________________

Shoreline Characterization

	Macrohabitat Shorezones			
	Swimming/Boating	Major Inlet	Least Affected	Affected
Present Water-Level Fluctuation (m):				
Riparian Vegetation Width (m):				
Percent Riparian Vegetation: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%)				
Dominant Shoreline Substrate: vegetated=VG, fine soil/sediment=FS (0-1 mm), sand=SA (1-2.5 mm), gravel=GV (2.5-64mm), cobble=CO (64-256 mm), boulder=BO (> 256mm), bedrock=BR				
Human Influences (indicate all that apply):				
Forestry				
Mining				
Agriculture				
Grazing				
Roads				
Urban/Residential				
Recreation				
Hydropower/Diversion				
Other ______				

2000 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Department of Environmental Quality

Name: ______________________ Site ID: 2000 Q ______ Date (YY/MM/DD): 00/ / ______

Associated Pelagic Station Description: ______________________

Littoral zone	Meters from shore	Macrohabitat Shorezone Transects											
		Swimming/Boating			Major Inlet			Least Affected			Affected		
		1	2	3	1	2	3	1	2	3	1	2	3
Littoral Bottom Substrate Indicate dominant substrate. vegetated=VG; fine soil/sediment=FS (0-1 mm), sand=SA (1-2.5mm), gravel=GV (2.5-64mm), cobble=CO (64-256mm), boulder=BO (> 256mm), bedrock=BR	1												
	2												
	3												
Periphyton Each entry should consist of a growth and form code. Growth: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%) Form: filamentous=FT, pin cushion=PC, gelatinous=GL	1												
	2												
	3												
Aquatic Macrophytes Each entry should consist of a growth and form code. Growth: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%) Form: short stature=SS, stems visible not reaching surface=SV, stems overlapping surface=SO, floating=FL	1												
	2												
	3												
Percent Aquatic Macrophyte Coverage:													
Number of Possible Aquatic Macrophyte Species:					**Aquatic Macrophyte Wet Weight (kg):**								

2000 Beneficial Use Reconnaissance Project Field Forms: Lakes and Reservoirs
Idaho Department of Environmental Quality

Name: ____________________ Site ID: 2000 Q ________ Date (YY/MM/DD): 00/ / ______

Associated Pelagic Station Description: ________________________________

Photograph Information

Roll (name or number): ____________________

Circle All That Apply:

Photo #: ______ Swimming/Boating Major Inlet Least Affected Affected
Photo #: ______ T1/!M T1/2M T1/3M T2/1M T2/2M T2/3M T3/1M T3/2M T3/3M
Photo #: ______ T1/!M T1/2M T1/3M T2/1M T2/2M T2/3M T3/1M T3/2M T3/3M
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Circle All That Apply:

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Additional Information

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Pelagic Station Location

Latitude (ddmmss): ______________ Longitude (ddmmss): ______________

Location Description: ______________________

Water-Quality Depth Profiles

Maximum Depth (ft or m): ______ Secchi Depth (m): ______ Hydrolab Filename: ______

Depth (m)	Temp. (C)	DO (ppm)	Conductivity	pH	Depth (m)	Temp. (C)	DO (ppm)	Conductivity	pH
1					14				
2					15				
3					16				
4					17				
5					18				
6					19				
7					20				
8					25				
9					30				
10					35				
11					40				
12					45				
13					50				
Indicate top (T) and bottom (B) of thermocline					Indicate top (T) and bottom (B) of thermocline				

Comments: ______________________

Name: ______________________ Site ID: 2000 Q ______ Date (YY/MM/DD): 00/ / ____

Pelagic Station Location

Latitude (ddmmss): ______________ Longitude (ddmmss): ______________

Location Description: ______________________

Chlorophyll a

Sample Volume Filtered (ml): ________ Duplicate Volume Filtered (ml): ________ Blank Volume Filtered (ml): ________

Comments: ______________________

Phytoplankton

Comments: ______________________

Nutrients

Comments: ______________________

Zooplankton

Comments: ______________________

Benthic Macroinvertebrate Sample Location

Latitude (ddmmss): ______________ Longitude (ddmmss): ______________

Location Description: ______________________

Comments: ______________________

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Associated Pelagic Station Description: ____________________

Shoreline Characterization

	Macrohabitat Shorezones			
	Swimming/Boating	Major Inlet	Least Affected	Affected
Present Water-Level Fluctuation (m):				
Riparian Vegetation Width (m):				
Percent Riparian Vegetation: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%)				
Dominant Shoreline Substrate: vegetated=VG, fine soil/sediment=FS (0-1 mm), sand=SA (1-2.5 mm), gravel=GV (2.5-64mm), cobble=CO (64-256 mm), boulder=BO (> 256mm), bedrock=BR				
Human Influences (indicate all that apply):				
Forestry				
Mining				
Agriculture				
Grazing				
Roads				
Urban/Residential				
Recreation				
Hydropower/Diversion				
Other ____________				

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Associated Pelagic Station Description: ____________________

Littoral zone

	Meters from shore	Macrohabitat Shorezone Transects											
		Swimming/Boating			Major Inlet			Least Affected			Affected		
		1	2	3	1	2	3	1	2	3	1	2	3
Littoral Bottom Substrate Indicate dominant substrate. vegetated=VG; fine soil/sediment=FS (0-1 mm), sand=SA (1-2.5mm), gravel=GV (2.5-64mm), cobble=CO (64-256mm), boulder=BO (> 256mm), bedrock=BR	1												
	2												
	3												
Periphyton Each entry should consist of a growth and form code. Growth: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%) Form: filamentous=FT, pin cushion=PC, gelatinous=GL	1												
	2												
	3												
Aquatic Macrophytes Each entry should consist of a growth and form code. Growth: none visible=NV (< 10%), sparse=SP (10-40%), moderate=MD (40-75%), thick=TK (> 75%) Form: short stature=SS, stems visible not reaching surface=SV, stems overlapping surface=SO, floating=FL	1												
	2												
	3												
Percent Aquatic Macrophyte Coverage:													
Number of Possible Aquatic Macrophyte Species:					**Aquatic Macrophyte Wet Weight (kg):**								

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Photograph Information

Roll (name or number): ______________________

Circle All That Apply:

Photo #:									
Photo #: ____	Swimming/Boating	Major Inlet	Least Affected	Affected					
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
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Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	Swimming/Boating	Major Inlet	Least Affected	Affected					
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Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
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Circle All That Apply:

Photo #:									
Photo #: ____	Swimming/Boating	Major Inlet	Least Affected	Affected					
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
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Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
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Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
Photo #: ____	T1/!M	T1/2M	T1/3M	T2/1M	T2/2M	T2/3M	T3/1M	T3/2M	T3/3M
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Additional Information

IDEQ-22, 850/5057, 7/00, Cost Per Unit: $3.04

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